PATENTS ACT 1949

SPECIFICATION NO 1480090

The following amendments were allowed under Section 29 on 21 November 1980:

Page 1, line 74, Page 3, line 10, *after* combustion *insert* of the cable
Page 1, lines 76 and 77, Page 3, line 13, *delete* a flame retardant *insert* ethylene-propylene rubber and/or butyl rubber as a minor component by weight, a filler and a flame retardant, the filling material forming an inorganic ash residue as a protective layer around the insulated conductor(s) when the cable is subject to combustion
Page 2, line 19, Page 3, line 38, *delete* filler *insert* filling
Page 2, lines 20 and 21, *delete* . The filler performs an important function *insert* which,
Page 2, line 22, *delete* since it
Page 2. line 28, *delete* preferably
Page 2, lines 29 and 30, *after* rubber *insert* as a minor component by weight
Page 2, line 37, *delete* The filler *insert* (The hydrated alumina also serves as the flame retardant.) The filling
Page 2, lines 71, 72, 75, 127 and 128, *delete* composition *insert* material
Page 2, line 78, *delete* medium *insert* material
Page 3, line 7, *delete* conductors *insert* conductor(s),
Page 3. *delete* lines 30 to 33
Page 3, *for* claims 5 to 9 *read* 4 to 8
Page 3, line 34, *for* 4 *read* 1, 2 or 3
Page 3, line 36, *after* alumina *insert* , the hydrated alumina also serving as the flame retardant
Page 3, line 37, *for* 5 *read* 4
Page 3, line 51, *after* filling *insert* material

THE PATENT OFFICE
19 January 1981

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This specification is subject to amendment. A notice will appear in the Official Journal when a reprint or an amendment slip is available.

PATENT SPECIFICATION

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SCIENCE REFERENCE LIBRARY

(54) ELECTRIC CABLE

(71) We, PIRELLI GENERAL CABLE WORKS LIMITED, a British Company, of Thavies Inn House, 3—4 Holborn Circus, London EC1N 2QA, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to electric cables, more particularly to electric cables having one or more individually insulated conductors for carrying control signals or power.

Flame-retardant cables are known wherein the insulation comprises compositions based on chlorine-containing elastomeric or plastics materials such as polychloroprene and polyvinyl chloride. For example, in some cables the or each conductor is individually insulated with an extruded layer of polyvinyl chloride and an extruded sheath of the same material encloses the insulated conductor(s). In other cables, the or each conductor is individually insulated with an extruded rubber composition and the whole enclosed within an extruded sheath of flame retardant composition based on polychloroprene or chlorosulphonated polyethylene.

It is known to produce good flame retardance by using, for the extruded insulation layers of the individual conductors and/or for the extruded sheath, compositions containing an elastomeric or plastics material (not necessarily chlorinated) as the basic component and including in the composition fire retardants such as antimony trioxide, chloroparaffins or diphenyl chloride. Patent specification 1,266,310 proposes an improvement wherein the insulating composition comprises from 6 to 40% magnesium carbonate, at least 20% of a chlorine-containing compound, an elastomeric or plastics material which may comprise at least in part the chlorine containing compound, and from 1 to 15% of antimony trioxide (the percentages being by weight).

However, when these known cables are subject to combustion, they do emit considerable quantities of dense black smoke which contains toxic hydrogen chloride. In tunnels and other enclosed spaces, for example tunnels for underground trains, there is an increasing demand for cables which evolve only minimal quantities of smoke under combustion, so as to reduce the risk of obscuring vision, to reduce the risk to human life from toxic and irritant gases such as hydrogen chloride, and to prevent costly damage to adjacent materials and equipment.

We have now devised an electric cable which is particularly (though not exclusively) useful in tunnels and other enclosed spaces, which does not produce dense smoke or gaseous acids when subjected to combustion.

The invention provides an electric cable which comprises one or more individually insulated conductors within a sheath of flame retardant insulating material, and an insulating filling material within the sheath and surrounding the individually insulated conductor(s), wherein the sheath, the insulation on each individual conductor(s), and the filling material are of compositions such that, upon combustion, no acidic gases are evolved and no dense smoke is formed, and wherein the filling material comprises a flame retardant.

The amount of smoke evolved on combustion of a cable of the invention is very substantially less than the amount evolved from conventional PVC cables or other cables based on chlorinated material. Some small amount of grey-white smoke may be evolved but the amount does not significantly obscure vision in, say, an underground railway tunnel.

For the avoidance of doubt, the expression "flame retardant" used herein has its well-known meaning, namely a substance having the property of retarding the propagation of flame.

Among the materials which are suitable for use for insulating the individual conductors are rubbers such as non-sulphur cured ethylene-propylene rubbers (hereinafter referred to as EPR), polyethylene which has been cross-linked chemically or by irradiation (hereinafter referred to as XLPE), non-sulphur cured butyl rubbers and thermo-

APPLICATION TO AMEND THIS SPECIFICATION advertised in Issue of O.J.(P.) dated 23 APR 1980

plastic rubbers. Thermoplastic polyethylene may be used where, for example, the outer sheath comprises flame retardant thermoplastic polyethylene, thereby avoiding the need to cure the sheath material.

Thermoplastic rubbers are known in the art. Such rubbers, which are commercially available, are synthetic and extrude easily. At extrusion temperatures, typically 200°C, they are thermoplastic but at ambient temperature their characteristics are those of a conventional rubber. Between the range −40°C to 100°C, they generally have elastic properties, but above 100°C they start to soften and become thermoplastic.

The suitability of rubber materials such as EPR and XLPE is surprising since these materials are flammable. However, this problem is overcome by using a filler material around the insulated conductors. The filler performs an important function when the cable is subject to combustion, since it forms an inorganic ash residue as a protective layer around the insulated conductor(s). Apart from comprising a small amount of rubber (to render it extrudable and coherent), it mainly comprises inorganic ash-forming ingredients. The filling material preferably comprises ethylene-propylene rubber and/or butyl rubber, a filler and a flame retardant. It is particularly preferred to include in the filling material a combination of hydrated alumina and ground whiting, since we have found that, surprisingly, such a filler forms a very good protective ash core around the insulated conductors when subjected to combustion. The filler material must be sufficiently hard to withstand the pressure of the rubber vulcanisation process (where used), and will normally have a very low polymer content, e.g. less than 10% by weight.

If it is desired to use, for the insulation on the conductors, a flame retardant material, then suitable materials include flame retardant silicone rubber, flame retardant cross-linked polyethylene and thermoplastic polyethylene containing an inorganic flame retardant.

Preferred materials for the sheath include flame retardant silicone rubber, flame retardant cross-linked polyethylene or thermoplastic polyethylene containing an inorganic flame retardant.

It is sometimes advantageous to provide around the sheath, a protective layer of a silicone rubber-coated glass tape. This protects the cable during installation and also, in the event of combustion, assists in retaining the envelope of silica ash around the cable.

In order that the invention may be more fully understood, reference is made to the accompanying drawing which is a cross-section of one form of cable according to the invention. Referring to the drawing, there is shown a power cable comprising three conductors 10, 11, 12 having respective individual, extruded insulating layers 14, 15, 16, the three insulated conductors being helically laid-up together. Each conductor may be round as shown or any suitable shape in cross-section. An insulating filling composition 18 fills the spaces between the adjacent insulated conductors and gives the laid-up conductor construction a circular outer surface. The filling composition is applied by extrusion. A tape 20 may be lapped helically around the conductors after application of the filling medium as shown. A sheath 22 is extruded over this, and the cable may be completed by the application of armouring layers (not shown) around the sheath 22.

By way of example, filling materials may have the following composition:

	Parts by Weight
EPR	100
Butyl Rubber	10 to 20
Polyethylene	30 to 60
Ground Whiting	1000 to 1500
Hydrated Alumina	250 to 500
Mineral Oil	100 to 150
Stearic Acid	10 to 20

Typical oxygen index values for this composition are in the range 33 to 40, depending on the relative proportions of the various constituents. In this example, the butyl rubber is included to assist the ease with which the composition can be extruded, but the composition could be based upon butyl rubber instead of upon EPR.

The sheath 22 is required to be flame retardant and the material from which it is made can be selected from flame retardant silicone rubber, such as for example the commercially available Midland Silicone MS1603, flame retardant cross linked polyethylene such as, for example, the commercially available Union Carbide HFDC 4770, and flame retardant thermoplastic polyethylene (providing in the latter that the flame retardant constituents are inorganic compounds only). In addition to the flame retardant properties of these materials they produce only low quantities of smoke which is free of hydrochloric and other acids. The sheath lends mechanical support to the cable to withstand the stresses to which the cable is subjected during handling and installation.

Although a power cable has been described, the invention is applicable to a cable for carrying control signals (for example signalling currents in an underground train system) and to telecommunications cables. The cable will then include a multiplicity of individually insulated conductors enclosed with an extruded sheath and with the spaces within the sheath filled with the filling composition.

WHAT WE CLAIM IS:—

1. An electric cable which comprises one or more individually insulated conductors within a sheath of flame retardant insulating material, and an insulating filling material within the sheath and surrounding the individually insulated conductors, wherein the sheath, the insulation on each individual conductor, and the filling material are of compositions such that, upon combustion, no acidic gases are evolved and no dense smoke is formed, and wherein the filling material comprises a flame retardant.

2. An electric cable according to claim 1, wherein the or each conductor is individually insulated with a layer of non-sulphur cured ethylene-propylene rubber, cross-linked polyethylene, non-sulphur cured butyl rubber, thermoplastic rubber or thermoplastic polyethylene, or flame retardant silicone rubber, flame retardant cross-linked polyethylene or thermoplastic polyethylene containing an inorganic flame retardant.

3. An electric cable according to claim 1 or 2, wherein the sheath is composed of flame retardant silicone rubber, flame retardant cross-linked polyethylene or thermoplastic polyethylene containing an inorganic flame retardant.

4. An electric cable according to claim 1, 2 or 3, wherein the filling material comprises ethylene-propylene rubber and/or butyl rubber, a filler and a flame retardant.

5. An electric cable according to claim 4, wherein the filler comprises ground whiting and hydrated alumina.

6. An electric cable according to claim 5, wherein the filler material comprises:

	Parts by Weight
Ethylene-Propylene Rubber	100
Butyl Rubber	10 to 20
Polyethylene	30 to 60
Ground Whiting	1000 to 1500
Hydrated Alumina	250 to 500
Mineral Oil	100 to 150
Stearic Acid	10 to 20

7. An electric cable according to any preceding claim, which has been made by forming the sheath, the filling and the insulation on each individual conductor, by extrusion.

8. An electric cable according to any preceding claim, which also comprises a layer of silicone rubber-coated glass tape around the sheath.

9. An electric cable substantially as herein described with reference to the accompanying drawing.

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1 480 090
1 SHEET

COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.